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PRELIMINARY BOTTOM LOSS DATA FROM EXPLOSIVE SOUND SOURCES IN AR--ETC(U)  
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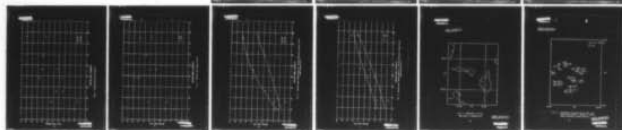
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PRELIMINARY BOTTOM LOSS DATA FROM  
EXPLOSIVE SOUND SOURCES IN AREA "A"

by

Robert S. Minokur and Paul M. Dunlap

31 December 1963

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ABSTRACT

66 deg 00 min

INTRODUCTION

67 deg 00 min W.

During September 1963, bottom loss data were taken in the southern half of the one-degree quadrangle extending from 36°00' to 37°00'N and 66°00' to 67°00'W. The data were taken at seven grazing angles ranging from 10° to 75° using Mark 22 sound signals as the sound sources. Frequency analyses were made at 1 and 4 kc. The purpose of the measurements was to determine preliminary suitability of the area for testing and evaluating bottom-bounce sonar.

Two ships were utilized while making the measurements. USS SAN PABLO (AGS-30) acted as the receiving ship, while USS SHELDRAKE (AGS-19) acted as the source ship. The bottom reflection loss measurements were made at seven locations along each of four tracks with each location corresponding to a different grazing angle.

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#### FIELD PROCEDURES AND ANALYSIS

USS SAN PABLO occupied the positions (A, B, C, D) shown in Figure 1 while USS SHELDRAKE occupied the Stations (1, 2, 3...7) along the indicated tracks. At each station, nine Mark 22 sound signals were dropped to a detonation depth of 3500 feet. An LC-32 hydrophone was lowered from USS SAN PABLO to a depth of 200 feet to receive the signals. Signals from the hydrophone were passed through three amplifiers onto three tracks of a multi-channel magnetic tape recorder. The magnetic tape recordings were made at 7-1/2 inches per second and played back at 1-7/8 inches per second through third octave filters onto an oscillographic recorder.

Bottom reflection loss was determined by applying appropriate corrections to the peak pressure level of the filtered bottom-reflected arrival and subtracting this result from a calculated one yard spectrum level. The energy spectrum level, equivalent to four pounds of TNT, was determined from Weston<sup>1</sup>. The spreading loss, absorption loss, and grazing angles were determined from the slant ranges computed from an IBM 7070 ray tracing program utilizing the sound velocity profile in Figure 2. Ship spacing and positioning were determined and maintained by radar and Loran-C. Absorption was determined by using  $\alpha = .01f^2$ , where  $f$  is frequency in kilocycles per second.

In order to verify the reflection loss values obtained by using a calculated source level, two check procedures were employed. Both check procedures have the advantage of being independent of source level and system calibration.

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The first check procedure used by Avco<sup>2,3</sup> permits bottom reflection loss to be computed by taking the difference between the level of first and second order bottom arrivals of the same shot. For example: the relative amplitude of the bottom-surface-bottom (BSB) arrival can be subtracted from that of the bottom-surface (BS) arrival to yield bottom loss. The difference between arrivals is then corrected for the difference in travel path. The main shortcoming of this method is that the grazing angle is not constant for the two arrivals and the loss determined is actually the loss at the second grazing angle plus the difference between the loss of the two grazing angles. What was computed, then, was this bottom loss for the average angle of the two arrivals.

The second check procedure determines bottom loss by utilizing the difference in amplitudes between the first bottom arrival of a known grazing angle and the bottom-surface-bottom arrival of a different station, but of the same grazing angle and along the same track. Bottom loss is again determined by correcting for the differences in spreading and absorption losses and by assuming no loss at the sea surface. For example: the grazing angle of the BSB arrival when the source ship is at Station 4 (Figure 1) is the same as the grazing angle of the bottom arrival for Station 2. The method has the disadvantage of using first and second order bottom arrivals of different shots as well as using arrivals that are reflected at different points.

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#### DISCUSSION

Figures 3 through 6 illustrate the bottom reflection loss along each track determined by using the first bottom arrival and a source level. Table 1 is a summary of all the data and also presents standard deviations for each grazing angle. A comparison of the two check procedures with the losses in Figures 3 through 6 showed the results obtained by the Avco procedure to have good agreement (less than 3 db differences) for grazing angles greater than 45 degrees and to have about 5 to 10 db higher losses for grazing angles less than 45 degrees.

The data obtained by the second check procedure showed good agreement (less than 3 db differences) for all grazing angles. The second check procedure is valid in areas or along tracks where the bottom loss, at a given grazing angle, is fairly consistent. It appears that this is such an area. The agreement between the source level method and this procedure indicates that the source level is fairly constant for all bombs and that the bottom losses and standard deviations are valid.

The reflection loss data along tracks 3 and 4 were easily fit by a second order least squares curves, whereas the losses along tracks 1 and 2 do not indicate such an orderly trend and did not permit such a fit.

The lowest bottom losses were encountered along track 4 while the highest losses were along track 2. The losses along track 3 tend to be about 3 db higher than track 4, but the curves maintain the same general shape and orderly progression.

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From the curves it can be seen that trends as well as variations encountered at 4 kc are also found at 1 kc. No apparent relationship between standard deviation and frequency or grazing angle was observed.

The general shape of the curves indicates a change in the bottom environment from the area surrounding tracks 3 and 4 to the area around tracks 1 and 2. The reason for the change in reflection loss between tracks is not known. From bathymetry taken during the survey and from Figure 7, no significant topographic variations that would affect reflection from the sea bottom can be observed. Short cores<sup>4</sup> taken in the area do not indicate substantial surface or near-surface sediment differences. The cores show the presence of a layer of medium to fine silt, near or at the water-sediment interface, distributed throughout the area. The area lies along the western edge of the Sohm Abyssal Plain<sup>5</sup> and is to the southeast of the mouth of the Hudson Canyon. The silt layer may be the result of turbidity current deposition resulting from the close proximity of the Hudson Canyon. The possible existence of a deeper sediment layer, due to turbidity currents, may account for the differences in reflection loss encountered within the area.

An examination of the oscillographic recordings indicates that the bottom is acting as a good specular reflector and does not appear to be a complex reflector or scatterer.

#### COMPARISON WITH OTHER DATA

Figure 8 illustrates 3.5-kc reflection losses encountered by the SQS-26 sonar<sup>6</sup> within this area. A comparison of these losses with the

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4-kc losses measured along tracks 1, 3, and 4 by using explosives shows good agreement. A comparison of the 4-kc data with the corrected 4-kc AMOS<sup>7,8</sup> bottom loss curve shows the AMOS data to be about 5 db higher than the losses along tracks 3 and 4 with better agreement along tracks 1 and 2.

#### CONCLUSION

From the reflection loss data obtained, it appears that the area surrounding track 4 would be the best sonar operating area, while track 2 would be an extremely poor operating area. The relatively high losses at a grazing angle of 38 degrees along track 1 will make this track a marginal sonar operating area at this grazing angle, whereas the lower losses at the lower grazing angles should permit SQS-26 operation. The area surrounding track 3 should also be a good operating area.

The fairly good agreement of the measured losses with the SQS-26 bottom loss data indicates the applicability of using explosives for making bottom loss measurements for sonar applications. It also appears that assuming a source level for the explosive and reading peak pressures do not introduce serious errors in the data.

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TABLE 1

SUMMARY OF REFLECTION LOSS DATA

| Track 1<br><u>Angle</u> | Mean loss (db) |             | Standard deviation (db) |             | No. of<br><u>Shots</u> |
|-------------------------|----------------|-------------|-------------------------|-------------|------------------------|
|                         | <u>4-Kc</u>    | <u>1-Kc</u> | <u>4-Kc</u>             | <u>1-Kc</u> |                        |
| Track 1                 |                |             |                         |             |                        |
| 75.5                    | 22.5           | 15.1        | 2.7                     | 2.8         | 8                      |
| 58.0                    | 16.3           | 10.1        | 2.2                     | 1.5         | 9                      |
| 45.5                    | 16.3           | 10.4        | 1.8                     | 2.1         | 9                      |
| 38.0                    | 17.6           | 9.0         | ---                     | ---         | 2                      |
| 26.0                    | 11.1           | 8.6         | 1.8                     | 1.3         | 8                      |
| 16.0                    | 12.3           | 3.1         | 3.1                     | 0.8         | 8                      |
| 10.0                    | 9.7            | 4.4         | 1.5                     | 1.5         | 9                      |
| Track 2                 |                |             |                         |             |                        |
| 74.5                    | 17.6           | 13.6        | 4.3                     | 4.5         | 9                      |
| 59.5                    | 16.4           | 15.4        | 3.8                     | 1.2         | 7                      |
| 46.0                    | 14.1           | 11.8        | 2.7                     | 2.1         | 9                      |
| 38.0                    | 20.0           | 18.5        | 1.7                     | 2.3         | 9                      |
| 27.0                    | 20.0           | 14.7        | 2.4                     | 2.0         | 9                      |
| 16.2                    | 14.6           | 7.6         | 2.5                     | 1.4         | 9                      |
| 9.5                     | 8.2            | 4.9         | 2.0                     | 1.0         | 8                      |
| Track 3                 |                |             |                         |             |                        |
| 74.5                    | 17.8           | 12.1        | 0.7                     | 0.5         | 9                      |
| 58.5                    | 16.2           | 9.5         | 1.0                     | 0.6         | 9                      |
| 45.5                    | 13.7           | 8.1         | 1.0                     | 2.5         | 8                      |
| 37.5                    | 14.0           | 6.1         | 1.0                     | 2.4         | 9                      |
| 27.0                    | 9.2            | 7.2         | 1.5                     | 1.4         | 8                      |
| 17.0                    | 5.8            | 1.6         | 1.2                     | 0.9         | 8                      |
| 10.0                    | 5.6            | 4.2         | 1.4                     | 2.6         | 9                      |

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TABLE 1 (Continued)

| Angle   | Mean loss (db) |             | Standard deviation (db) |             | No. of Shots |
|---------|----------------|-------------|-------------------------|-------------|--------------|
|         | <u>4-Kc</u>    | <u>1-Kc</u> | <u>4-Kc</u>             | <u>1-Kc</u> |              |
| Track 4 |                |             |                         |             |              |
| 75.4    | 14.2           | 13.0        | 1.4                     | 1.4         | 9            |
| 60.5    | 12.1           | 5.7         | 2.6                     | 1.1         | 9            |
| 45.5    | 11.8           | 3.6         | 2.0                     | 1.1         | 9            |
| 39.0    | 9.0            | 6.5         | 3.2                     | 1.9         | 7            |
| 27.0    | 7.5            | 4.0         | 1.7                     | 2.9         | 9            |
| 17.0    | 5.4            | 1.3         | 2.1                     | 2.1         | 8            |
| 10.0    | 5.8            | 3.8         | 1.7                     | 1.7         | 8            |

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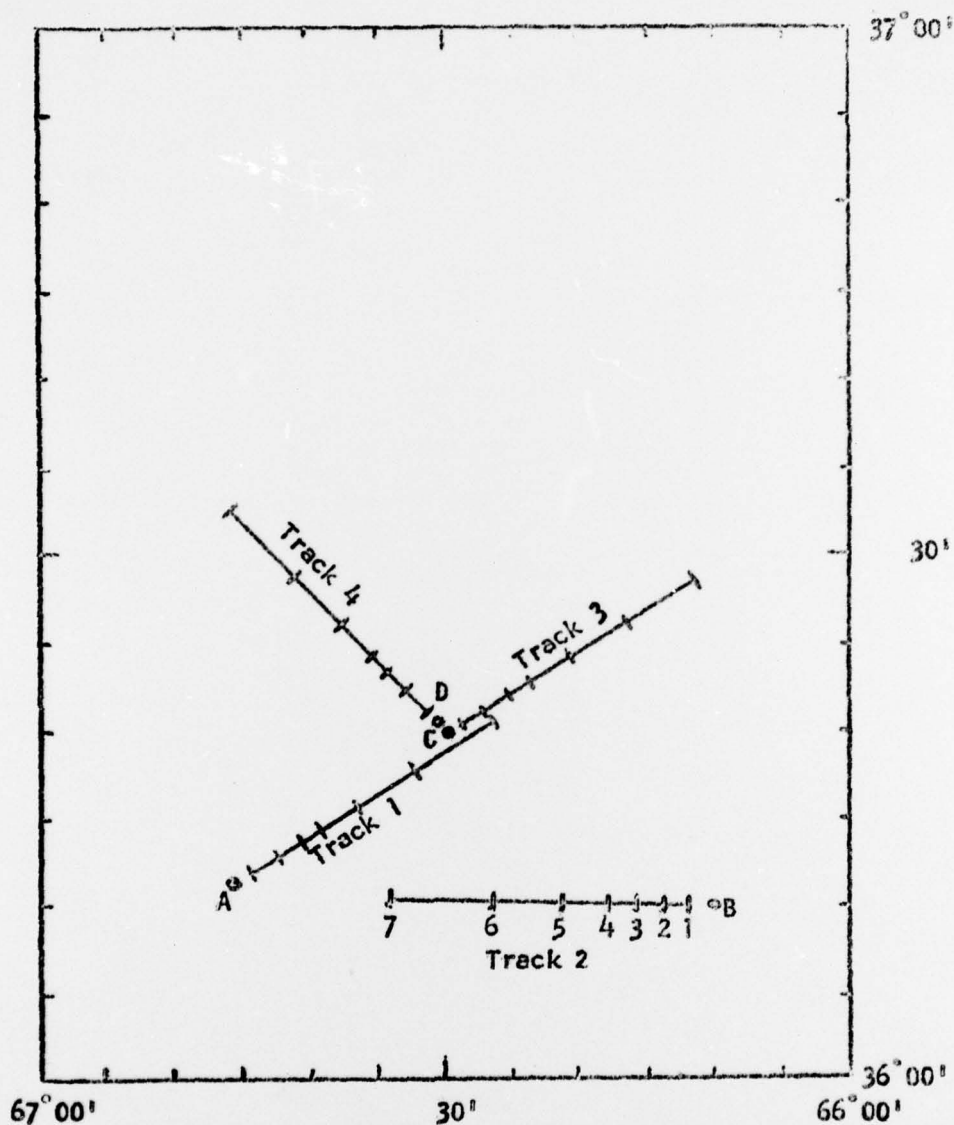


Fig. 1 Area A - Location of bottom loss measurements.  
Position of USS SAN PABLO indicated by A, B, C,  
D. USS SHELDRAKE indicated by 1, 2, 3...7.

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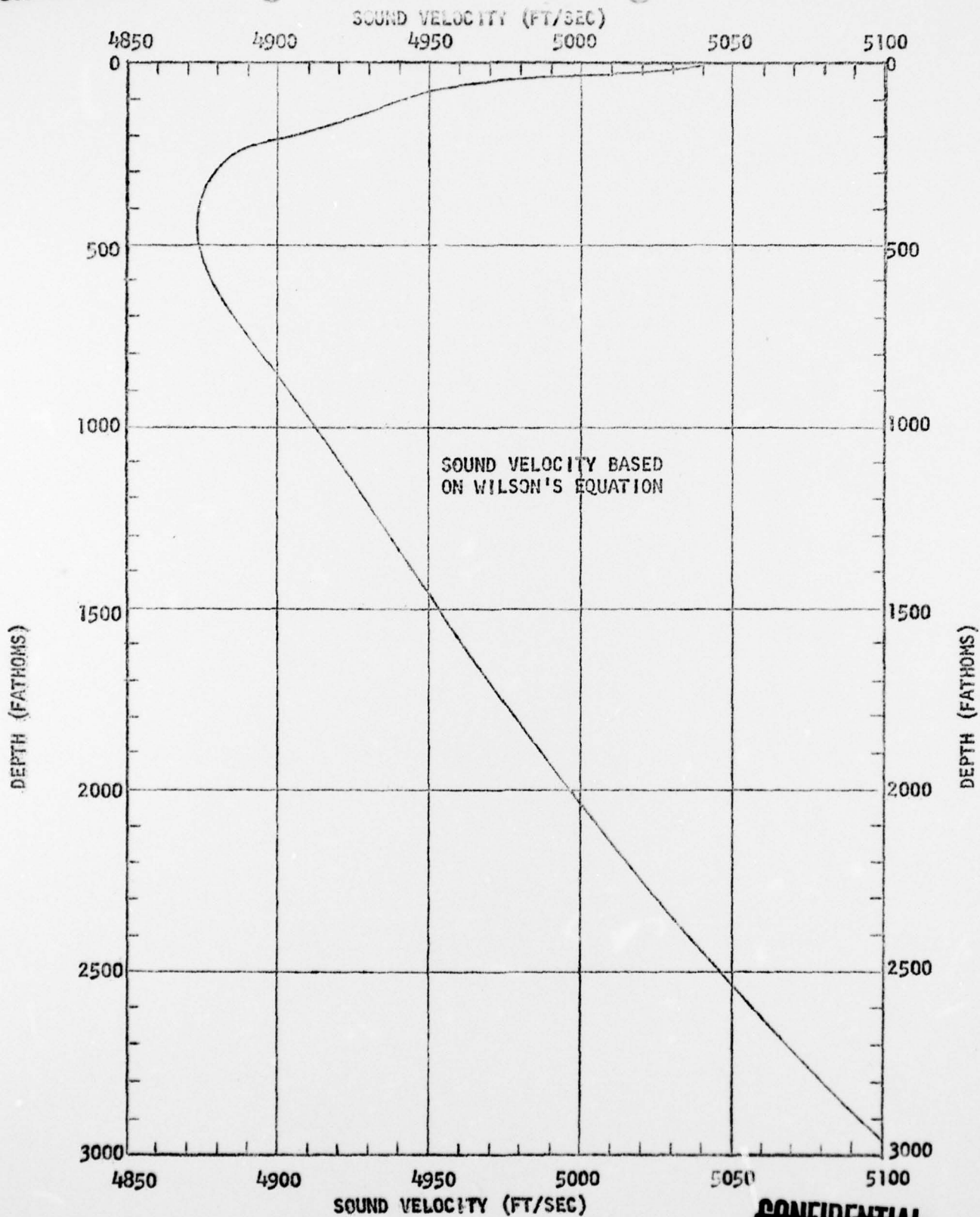


Fig. 2 Sound Velocity Profile

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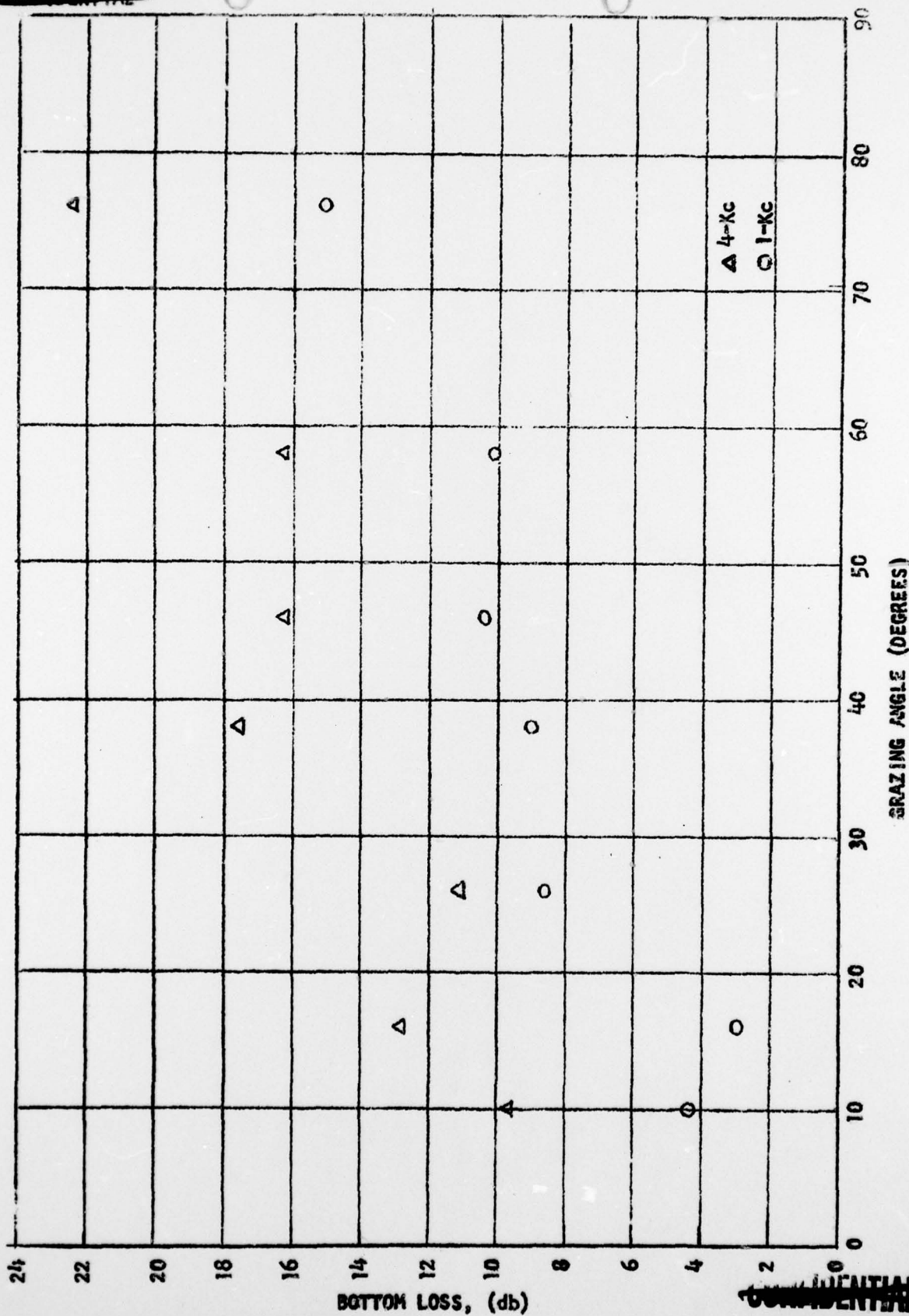
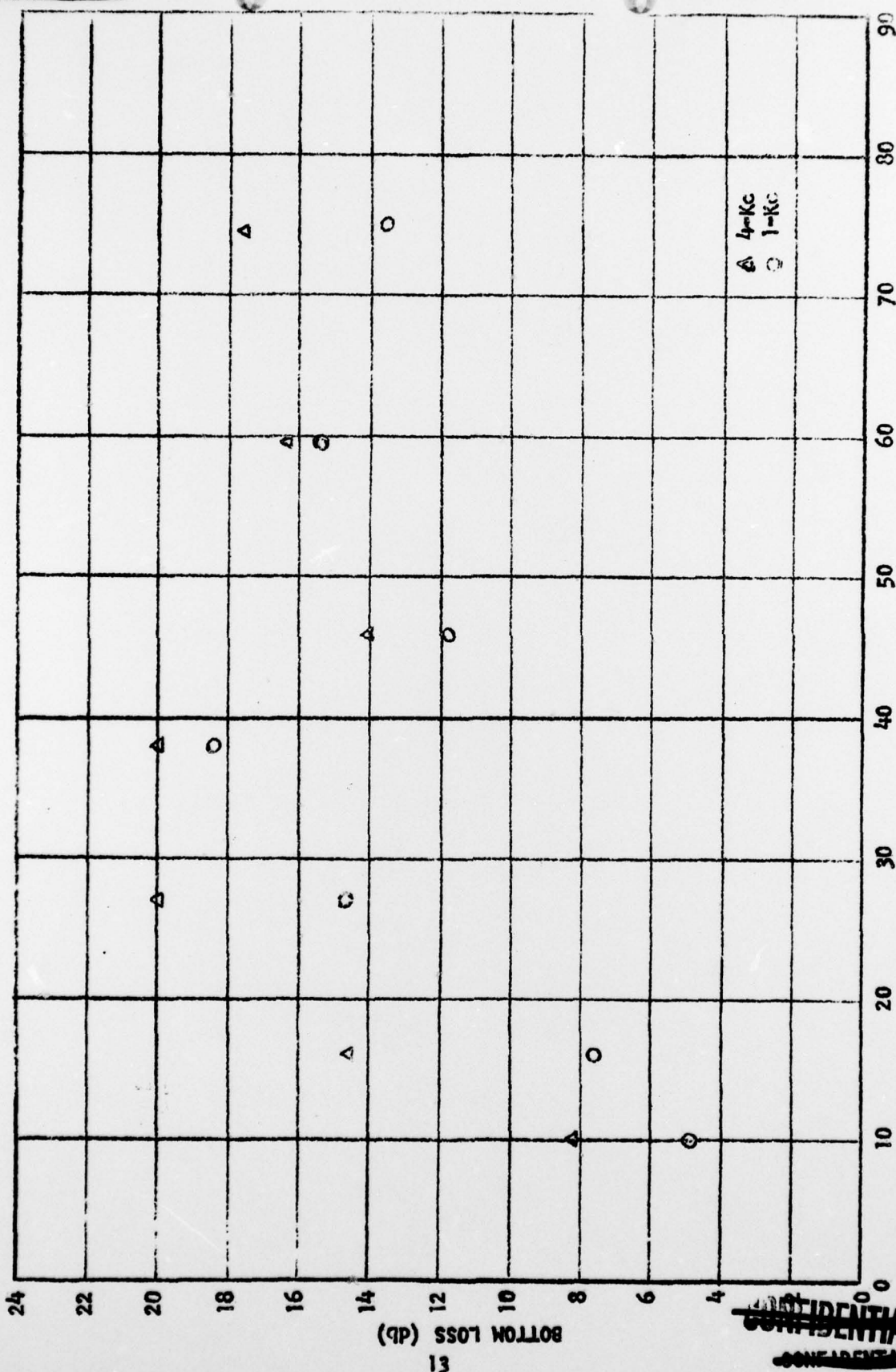


Fig. 3 Bottom Loss Along Track 1

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GRAZING ANGLE (DEGREES)

Fig. 4, Bottom Loss Along Track 2

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BOTTOM LOSS (db)

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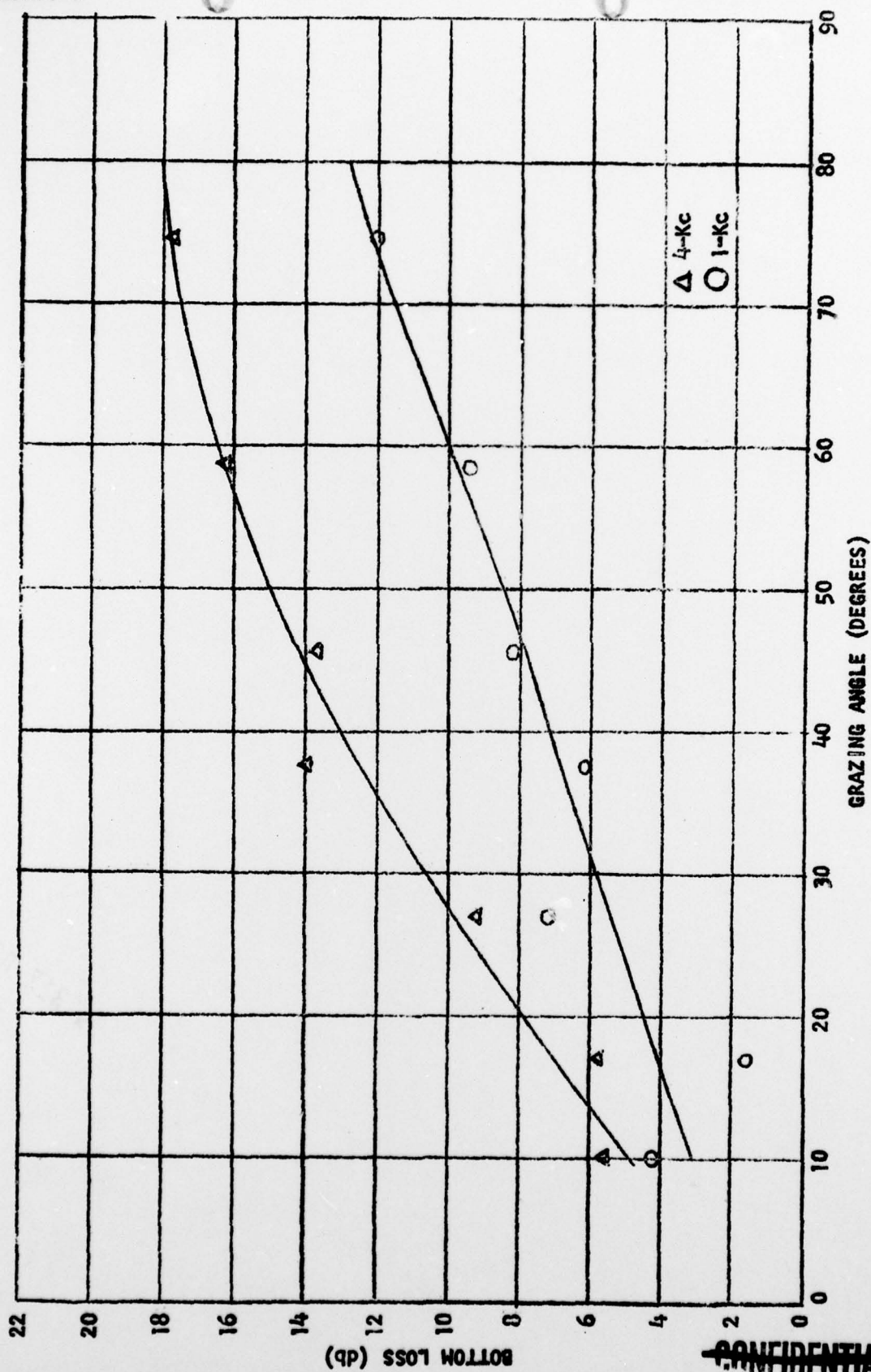


Fig. 5 Bottom Loss Along Track 3. Curves Represent Second Order Least Squares Fit.

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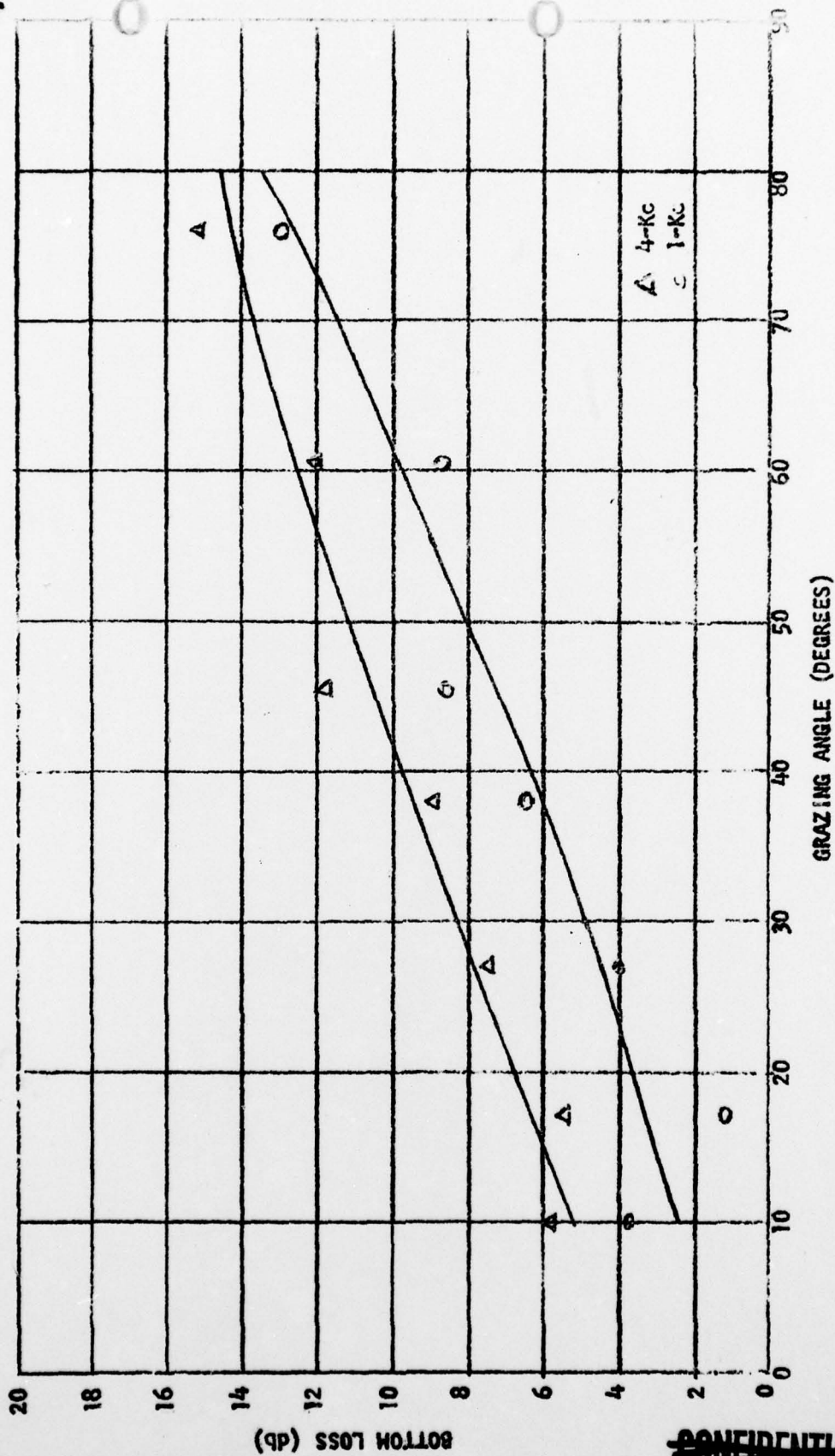


Fig. 6 Bottom Loss Along Track 4. Curves Represent Second Order Least Squares Fit.

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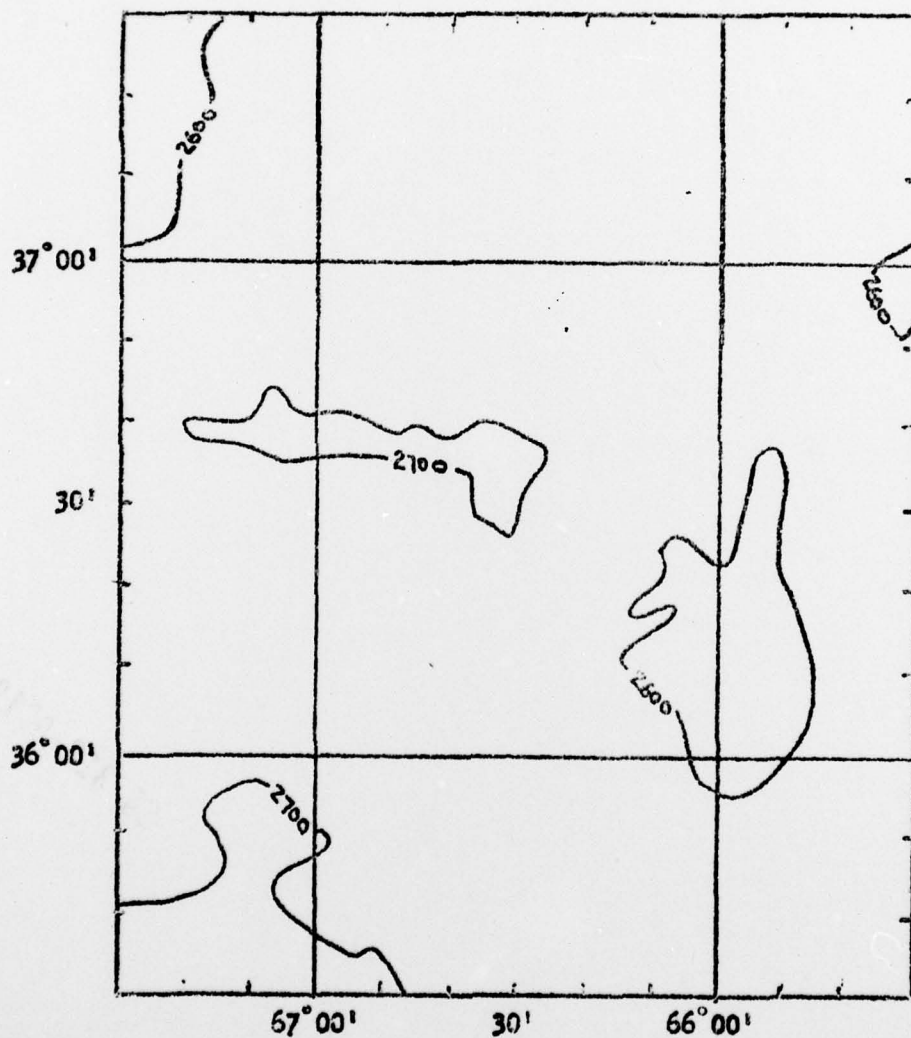


Fig. 7 Bathymetry of Arca.  
(New Chart in Preparation)

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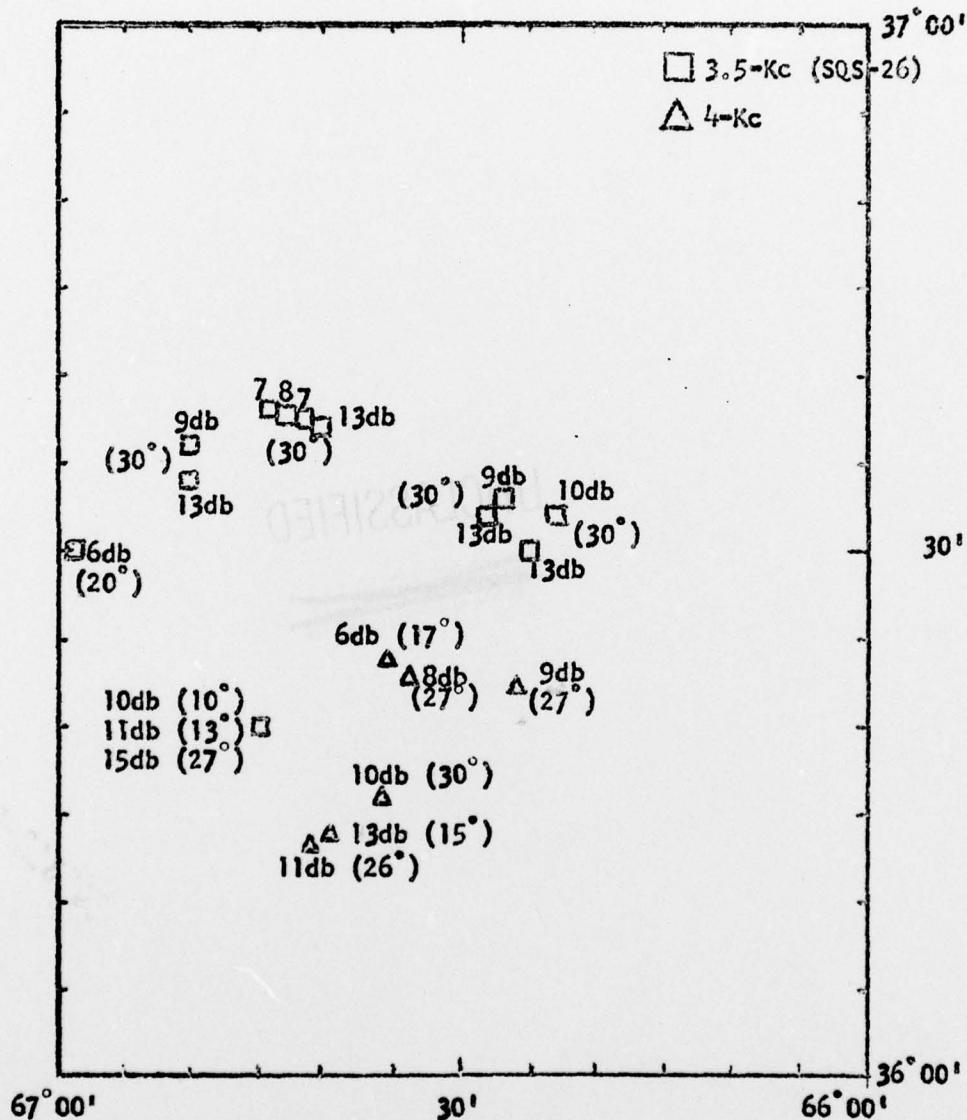


Fig. 8

Comparison of 3.5-Kc bottom loss with 4-Kc bottom losses. Numbers in parentheses represent grazing angles.

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